What I claim is:

1. A digging position determining method for a non-open-cut method of excavation, comprising the steps of:

sensing an AC magnetic field provided from a magnetic field source by an above-ground magnetic sensor and calculates the position of the magnetic field source from the magnitude and direction of the sensed magnetic field, when there is present, in addition to a signal magnetic field generated by said magnetic field source, a noise magnetic field generated by a nearby current, and

calculating at lease one of the position of said magnetic field source, the tilt angle of said magnetic field source to the vertical direction and the azimuth of said magnetic field source that is its axial direction in a horizontal plane; through

using a projective component of said magnetic field, sensed by said magnetic sensor, on a plane or straight line orthogonal to a vector-valued direction of said noise magnetic field, or using a signal magnetic field component obtained by synchronous detection of an original sensed magnetic field through utilization of said projective component as a reference signal.

2. A digging position determining method according to claim 1, characterized in that a vector-valued direction of said noise magnetic field is detected prior to the position determination in the absence of any nearby magnetic field source.

3. A digging position determining method according to claim 1, characterized in that a vector-valued direction of the frequency component of said noise magnetic field different from the frequency component of said signal magnetic field is detected and is regarded as a vector-valued direction of a noise magnetic field of the same frequency component as that of said signal magnetic field.

4. A digging position determining method according to claim 3, characterized in that:

a vector-valued direction of the frequency component of each sensed magnetic field different from the frequency component of said signal magnetic field is calculated; and

a vector-valued direction of the frequency component of said noise magnetic field, at which a fluctuation in the amplitude or direction of a projective component of said sensed magnetic field on a plane or line orthogonal to said vector-valued direction of said sensed magnetic field becomes minimum or smaller than a predetermined value, is regarded as a vector-valued direction of said noise magnetic field of the same frequency component as that of said signal magnetic field.

5. A digging position determining method according to claim 4, characterized in that:

a vector-valued direction of a line spectrum component of said noise magnetic field of a frequency component different from that of said signal magnetic field is calculated; and

a vector-valued direction of the line spectrum component of said noise magnetic field, at which a fluctuation in the amplitude or direction of a projective component of said sensed magnetic field on a plane or line orthogonal to said vector-valued direction of said noise magnetic field becomes minimum or smaller than a predetermined value, is regarded as a vector-valued direction of said noise magnetic field of the same frequency component as that of said signal magnetic field.

6. A digging position determining method according to claim 1, characterized in that: said signal magnetic field is turned OFF by a predetermined procedure; the OFF period of said signal magnetic field is estimated; and the direction of said sensed magnetic field during said OFF period is regarded as said vector-valued direction of said noise magnetic field.

7. A digging position determining method according to claim 6, characterized in that: a decrease in the intensity of said sensed magnetic field is detected to thereby estimate the OFF period of said signal magnetic field.

8. A digging position determining method according to claim 6, characterized in that:

said signal magnetic field is periodically turned OFF by a predetermined procedure;

a time correlation function in a finite period is calculated between a sequence, which takes a first numerical value during the OFF period of said signal magnetic field and a second numeral value different from said first value during an ON period of said signal magnetic field and is a time function of a "0" time average, and the absolute value of said sensed magnetic field or square root of said absolute value, or the absolute value of each vector-valued component of said sensed magnetic field or square root of said absolute value; and

a period is set during which said signal magnetic field is held OFF by said sequence that maximizes and minimizes said time correlation function when said first numerical value is larger than said second numerical value and minimizes said time correlation function when said first numerical value is smaller than said second numerical value, and the direction of said sensed magnetic field in said period is regarded as the direction of said noise magnetic field.

9. A digging position determining method according to claim 6, characterized in that:

said signal magnetic field is periodically turned OFF by a predetermined procedure;

said signal magnetic field is turned ON and OFF with a predetermined period following a sequence that takes a first numerical value during the OFF period of said signal magnetic field and a second numeral value different from said first value during an ON period of said signal magnetic field and is a time function of a "0" time average;

a time correlation function in a finite period is calculated between said sequence and the absolute value of said sensed magnetic field or square root of said absolute value, or the absolute value of each vector-valued component of said sensed magnetic field or square root of said absolute value;

a plurality of starting times of said sequence, which maximizes said time

correlation function in excess of a predetermined value when said first numerical value is larger than said second numerical value and minimizes said time correlation function when said first numerical value is smaller than said second numerical value, is set;

the first one of said plurality of starting times is subtracted from the remaining other starting times to obtain the time difference and an average value of said remaining starting times except an integral multiple of a period closest to said time difference is calculated; and

a period is set during which said signal magnetic field is held OFF by a sequence whose starting time is the sum of said average value and said first starting time, and the direction of said sensed magnetic field during said period is regarded as the direction of said noise magnetic field.

10. A digging position determining method according to claim 6, characterized in that:

said signal magnetic field is periodically turned OFF by a predetermined procedure;

a time correlation function in a finite period is calculated between a sequence, which takes a first numerical value during the OFF period of said signal magnetic field and a second numeral value different from said first value during an ON period of said signal magnetic field and is a time function of a "0" time average, and the absolute value of each vector-valued component of said sensed magnetic field or a square root of said absolute value; and

the direction of a vector formed by said three time correlation functions, in which a fluctuation in the amplitude or direction of a projective component of said sensed magnetic field on a plane or line orthogonal to the direction of said vector becomes minimum, is regarded as the direction of said noise magnetic field.

11. A digging position determining method according to claim 6, characterized in that:

said signal magnetic field is periodically turned OFF by a predetermined

procedure;

a period longer than the period for which said signal magnetic field is held OFF is divided into time intervals shorter than said signal magnetic field OFF period, and a vector-valued direction of said sensed magnetic field during each of said time intervals is detected; and

a vector-valued direction of said each time interval, in which a fluctuation in the amplitude or direction of a projective component of said sensed magnetic field on a plane or line orthogonal to a vector-valued direction of said sensed magnetic field in said each time interval becomes minimum, is regarded as a vector-valued direction of said noise magnetic field.

12. A digging position determining method according to claim 6, characterized in that:

said signal magnetic field is periodically turned OFF by a predetermined procedure;

time correlation functions in a finite period are calculated between a sequence, which takes a first numerical value during the OFF period of said signal magnetic field and a second numeral value different from said first value during an ON period of said signal magnetic field and is a time function of a "0" time average, and the absolute values of three vector-valued components of said sensed magnetic field or square roots of said absolute values; and

the time for executing one round of said sequence is divided into time intervals shorter than said signal magnetic field OFF period, and a vector-valued direction of each of said time intervals, in which a fluctuation in the amplitude or direction of a projective component of said sensed magnetic field on a plane or line orthogonal to vectors of three components of said time correlation functions becomes minimum at a representative time of said each time interval, is regarded as a vector-valued direction of said noise magnetic field.

13. A digging position determining method according to claim 1, characterized in that said signal magnetic field generated by said magnetic field source is

virtually symmetrical with respect to one axis of symmetry.

14. The digging position determining method as claimed in claim 13, characterized in that:

when the number of noise magnetic fields affecting the digging position determination is virtually only one and the tilt angle of said magnetic field source is known which is an inclination of the axis of symmetry corresponding to the axial direction of said signal magnetic field set in said magnetic field source with respect to the vertical direction, a projective component of a magnetic field, sensed at each of two or more different positions, on a plane orthogonal to the direction of said noise magnetic field sensed at each of said magnetic field sensing positions is calculated; and

the position of the magnetic field source and the azimuth angle of said magnetic field source that is the direction of said axis of symmetry in a horizontal plane are calculated from said projective component or a signal magnetic field component obtained by synchronous detection of the original sensed magnetic field through the use of said projective component as a reference signal.

15. A digging position determining method according to claim 1, characterized in that:

when the number of noise magnetic fields affecting the digging position determination is virtually only one, a projective component of a magnetic field, sensed at each of three or more different positions, on a plane orthogonal to the direction of said noise magnetic field sensed at each of said magnetic field sensing positions is calculated; and

the position of the magnetic field source, the tilt angle of said magnetic field source that is an inclination of the axis of symmetry corresponding to the axial direction of said signal magnetic field set in said magnetic field source with respect to the vertical direction, and the azimuth angle of said magnetic field source that is the direction of said axis of symmetry in a horizontal plane are calculated from said projective component or a signal magnetic field component obtained by

synchronous detection of the original sensed magnetic field through the use of said projective component as a reference signal.

16. A digging position determining method according to claim 1, characterized in that:

when the number of noise magnetic fields affecting the digging position determination is virtually only one and the tilt angle of said magnetic field source is known which is an inclination of the axis of symmetry corresponding to the axial direction of said signal magnetic field set in said magnetic field source with respect to the vertical direction, a projective component of said magnetic field, sensed at each of four or more different positions, on a plane orthogonal to the directions of both first and second noise magnetic fields sensed at each of said magnetic field sensing positions is calculated; and

the position of the magnetic field source and the azimuth angle of said magnetic field source that is the direction of said axis of symmetry in a horizontal plane are calculated from said projective component or a signal magnetic field component obtained by synchronous detection of the original sensed magnetic field through the use of said projective component as a reference signal.

17. A digging position determining method according to claim 1, characterized in that:

when the number of noise magnetic fields affecting the digging position determination is virtually only first and second noise magnetic fields, a projective component of said magnetic field, sensed at each of four or more different positions, on a plane orthogonal to the directions of both said first and second noise magnetic fields sensed at each of said magnetic field sensing positions is calculated; and

the position of the magnetic field source, the tilt angle of said magnetic field source that is an inclination of the axis of symmetry corresponding to the axial direction of said signal magnetic field set in said magnetic field source with respect to the vertical direction, and the azimuth angle of said magnetic field source

that is the direction of said axis of symmetry in a horizontal plane are calculated from said projective component or a signal magnetic field component obtained by synchronous detection of the original sensed magnetic field through the use of said projective component as a reference signal.

18. A digging position determining method according to claim 1, characterized in that:

when the number of noise magnetic fields affecting the digging position determination is virtually only first and second noise magnetic fields,

the frequency component of said first noise component, around which said second noise magnetic field and said signal magnetic field have substantially no frequency components, are measured to thereby obtain a vector-valued direction of said first noise magnetic field, and

the frequency component of said second noise component, around which said first noise magnetic field and said signal magnetic field have substantially no frequency components, are measured to thereby obtain a vector-valued direction of said second noise magnetic field.

19. A digging position determining method according to claim 1, characterized in that said magnetic sensor is a three-axis magnetic sensor that senses magnetic fields of three axial directions orthogonal to one another at substantially the same position.

20. A digging position determining method according to claim 19, characterized in that:

a frame is used which is provided with magnetic sensor fixing means for removably or fixedly mounting said three-axis magnetic sensor; and

said frame is provided with a tilt angle sensor fixed to said frame, for sensing the tilt angle of an orthogonal coordinate system to a vertical direction;

wherein: other magnetic fields are sensed by said three-axis magnetic sensor removably or fixedly mounted on each of a required number of magnetic sensor fixing means that are mounted on said frame so that the position and

orientation of said magnetic sensor fixing means with respect to said frame are known; and

the tilt angle of said frame at the time of sensing said other magnetic fields and the orientation of said three-axis magnetic sensor at each three-axis magnetic sensor mounting position with respect to said frame are used to calculate said sensed magnetic field, said noise magnetic field and said signal magnetic field as vectors in a coordinate system fixed to the ground from said other magnetic fields sensed at said each three-axis magnetic sensor mounting position.

21. A digging position determining method according to claim 19, characterized in that said other magnetic fields are sensed by said three-axis magnetic sensor fixed at each of a required number of magnetic sensor mounting positions.

22. A digging position determining method according to claim 19, characterized in that magnetic fields are sensed by one three-axis magnetic sensor that is removably mounted at said required number of magnetic sensor mounting positions one after another.

23. A digging position determining method according to claim 1, characterized in that said magnetic field generating means is a coil.

24. A digging position determining method according to claim 1, characterized in that said magnetic field generating means is an electric wire.

25. A digging position determining method according to claim 1, characterized in that said magnetic field generating means is a straight electric wire disposed in the vicinity of the magnetic field sensing position.